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INJURY BIOMECHANICS RESEARCH
Proceedings of the Twelfth International Workshop

A VISCOUS TOLERANCE CRITERION

a presentation to:

12th ANNUAL INTERNATIONAL
WORKSHOP ON HUMAN SUBJECTS FOR
BIOMECHANICAL RESEARCH

November 5, 1984

Ian V. Lau, Ph.D.

Biomedical Science Department
GM Research Laboratories
Warren, MI 48090

ABSTRACT

A viscous criterion, represented by the product of the instantaneous compression and velocity of compression [V*C], is proposed as an index of tissue vulnerability to blunt trauma by a velocity sensitive mechanism. The criterion is supported by available physiologic data. Liver injury was found to be directly proportional to impact velocity when abdominal compression was constant at 16%. The interdependence between impact velocity and compression in producing pulmonary injury was demonstrated in an animal model. [V*C]max was also found to correlate well with injury in cadaver experiments. [V*C]max = constant differentiated critical/lethal injuries from nonlethal injuries in animal experiments. The viscous criterion was found to be the best predictor of injury for impact velocities above 5 m/s. The criterion can be adopted for measurements in dummies with current technology.

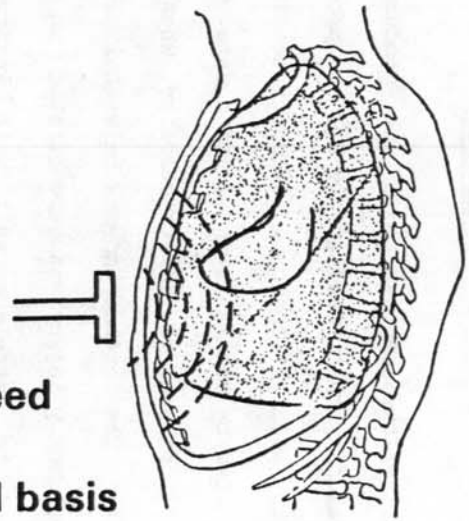
PROPOSED CHEST INJURY CRITERION

III. VISCOUS COMPONENT

(V*C) **m/s**

[For frontal injuries, Viano and Lau, 1983]

The criterion:



* **assesses the risk from high speed impacts.**
* **has physiologic and theoretical basis**
* **is practical for measurement in dummies.**

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REFERENCES FOR VISCOUS INJURY CRITERION

Lau and Viano: Influence of Impact Velocity on the Severity of Nonpenetrating Hepatic Injury. *J. Trauma* 21: 115-123, 1981.

Lau and Viano: Influence of Impact Velocity and Chest Compression on Experimental Pulmonary Injury Severity in Rabbits. *J. Trauma* 21: 1022-1028, 1981.

Lau: Effect of Timing and Velocity of Impact on Ventricular Myocardial Rupture. *J. Biomech. Engr.* 105: 1-5, 1983.

Viano and Lau: Role of Impact Velocity and Chest Compression in Thoracic Injury. *Aviat. Space Environ. Med.* 54: 16-21, 1983.

Rouhana, Lau and Ridella: Influence of Velocity and Forced Compression on the Severity of Abdominal Injury in Blunt, Nonpenetrating Lateral Impact. *GMR Publication* 4763, 1984.

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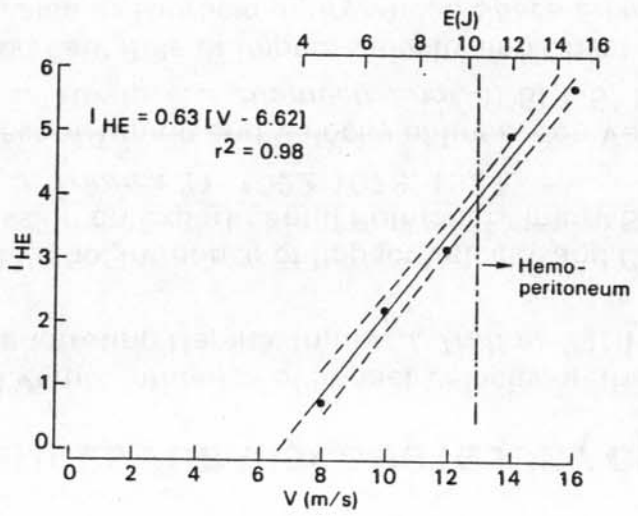
HEPATIC INJURY AS A FUNCTION OF IMPACT VELOCITY
C = 16%



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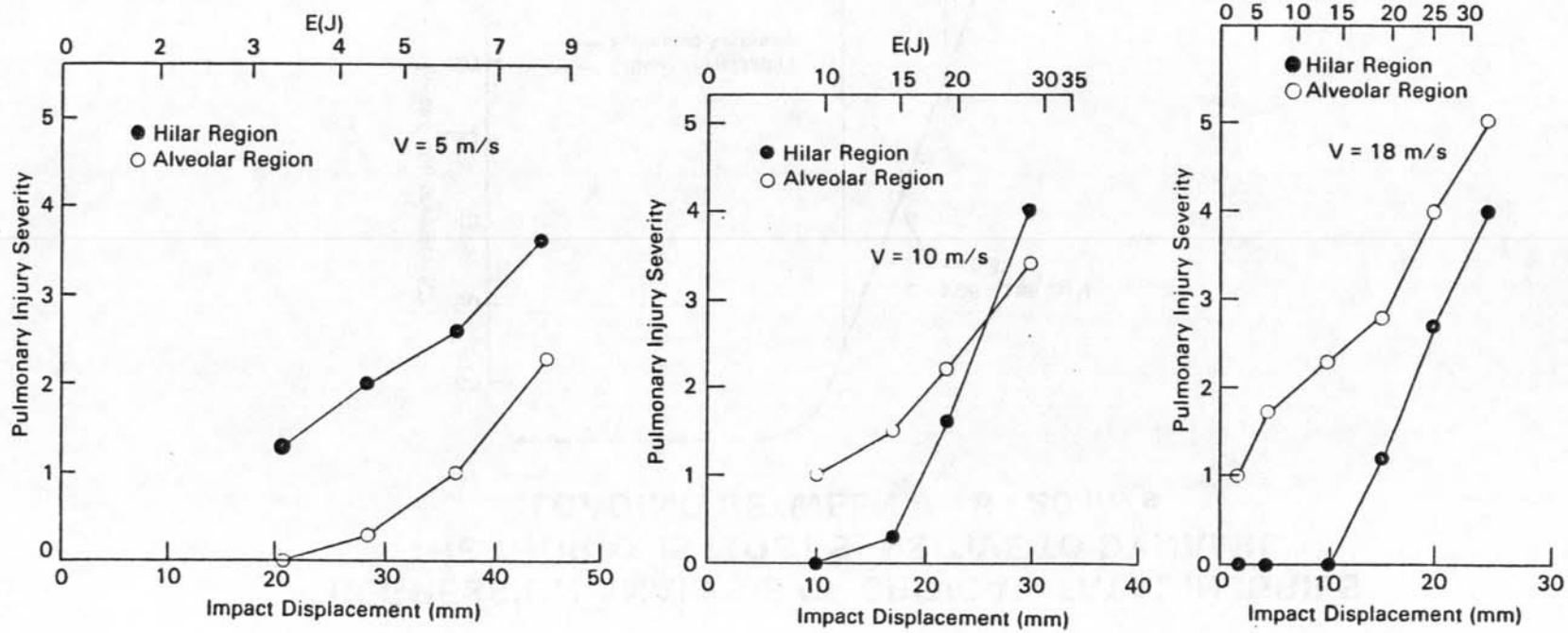
PULMONARY INJURY AS A FUNCTION OF DISPLACEMENT AT THREE IMPACT VELOCITIES



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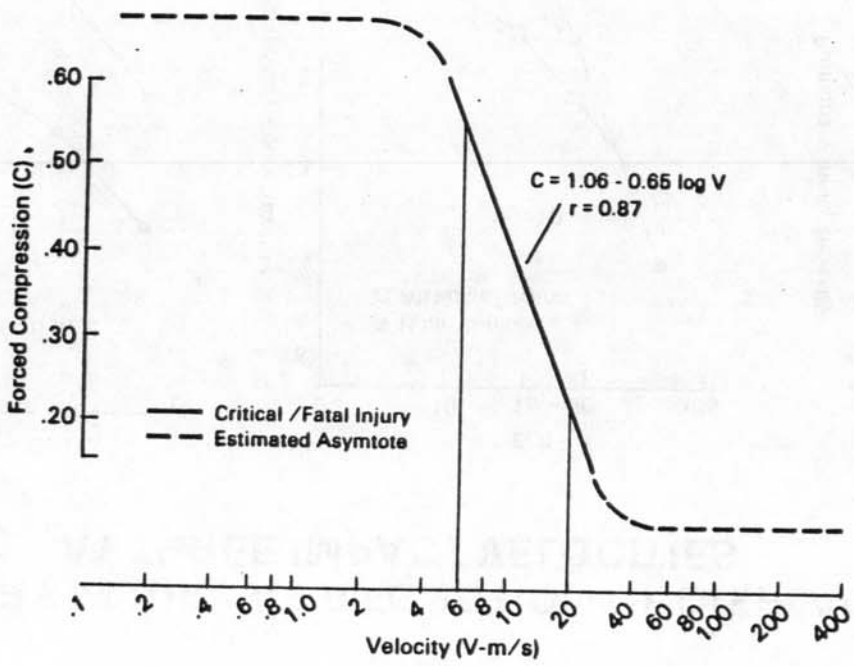
REGRESSION ANALYSIS OF CRITICAL/FATAL INJURIES THE THORAX IS MOST SENSITIVE TO DYNAMIC LOADING BETWEEN V = 6 - 20 m/s



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CONCLUSIONS

1. Viscous tolerance of the thorax can be represented as (V*C)
2. Differs from existing inertial and elastic criteria and should be considered for supplementing them.
3. Particularly important for high speed (>5 m/s) impact injury evaluation.
4. Can be easily adopted for use in dummies.

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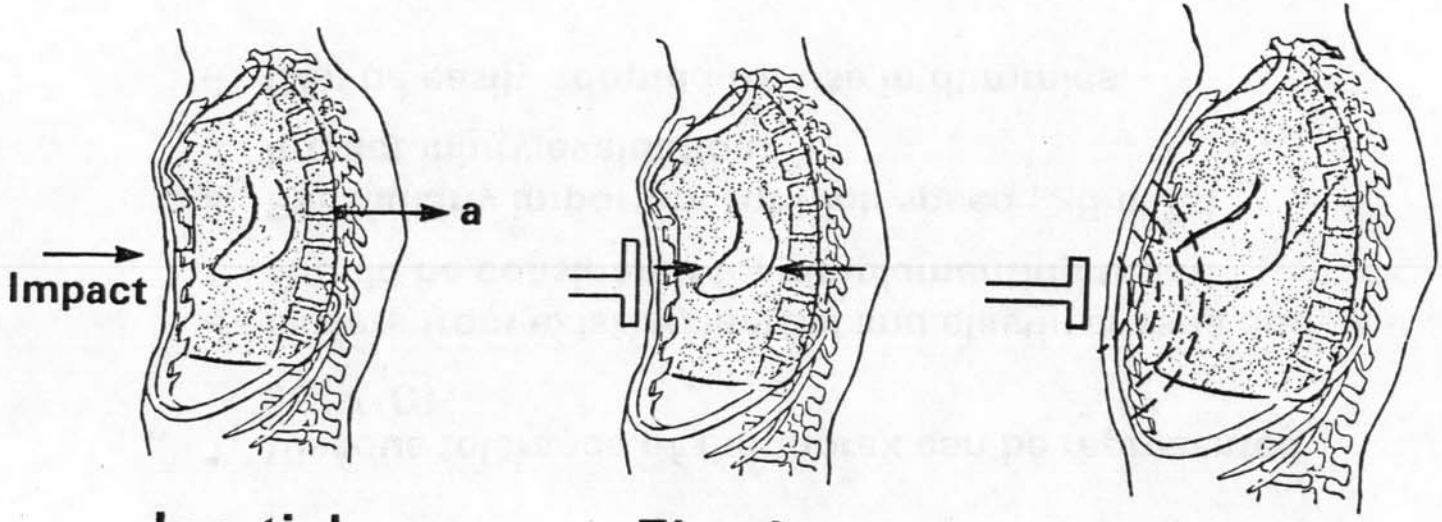
INJURY CRITERIA NECESSARY TO ACCOUNT FOR ALL INJURY MECHANISMS



Inertial Criterion a

Elastic Criterion P/D

Viscous Criterion V*C

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